

# BUK7504-40A

## N-channel TrenchMOS standard level FET

Rev. 03 — 15 June 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Standard level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 1.2 Features and benefits

- Low conduction losses due to low on-state resistance
- Q101 compliant
- Suitable for standard level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

### 1.3 Applications

- 12 V loads
- Automotive and general purpose power switching
- Motors, lamps and solenoids

### 1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$	-	-	40	V
$I_D$	drain current	$V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 3</a> ; see <a href="#">Figure 1</a>	[1]	-	75	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>	-	-	300	W
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 175\text{ °C}$ ; see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	-	8.5	mΩ
		$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	3.9	4.5	mΩ



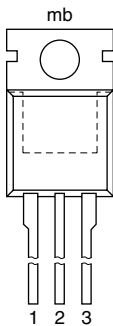
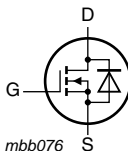
**Table 1. Quick reference data ...continued**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 75\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\ \Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(init)} = 25\text{ }^\circ\text{C}$ ; unclamped	-	-	1.6	J
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $V_{DS} = 32\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; see <a href="#">Figure 13</a>	-	50	-	nC

[1] Continuous current is limited by package.

## 2. Pinning information

**Table 2. Pinning information**

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
2	D	drain		
3	S	source		
mb	D	mounting base; connected to drain		

**SOT78 (TO-220AB)**

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		Version
	Name	Description	
BUK7504-40A	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

## 4. Limiting values

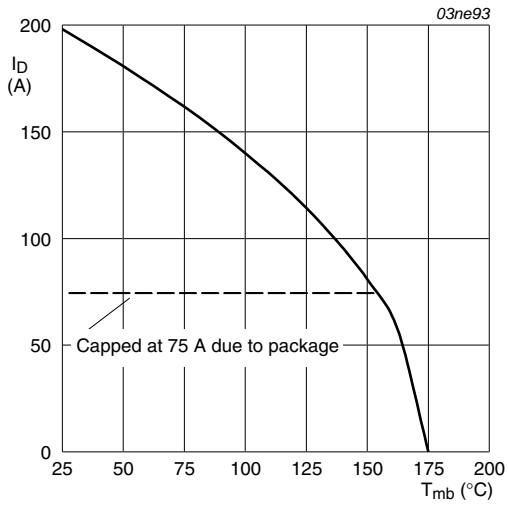
**Table 4. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$	-	-	40	V
$V_{DGR}$	drain-gate voltage	$R_{GS} = 20\text{ k}\Omega$	-	-	40	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 3</a> ; see <a href="#">Figure 1</a>	[1]	-	198	A
		$T_{mb} = 100\text{ °C}; V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 1</a>	[2]	-	75	A
		$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 3</a> ; see <a href="#">Figure 1</a>	[2]	-	75	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ °C}; t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; see <a href="#">Figure 3</a>	-	-	794	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>	-	-	300	W
$T_{stg}$	storage temperature		-55	-	175	°C
$T_j$	junction temperature		-55	-	175	°C
<b>Source-drain diode</b>						
$I_S$	source current	$T_{mb} = 25\text{ °C}$	[1]	-	198	A
			[2]	-	75	A
$I_{SM}$	peak source current	$t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; $T_{mb} = 25\text{ °C}$	-	-	794	A
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 75\text{ A}; V_{sup} \leq 40\text{ V}; R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 10\text{ V}; T_{j(init)} = 25\text{ °C}$ ; unclamped	-	-	1.6	J

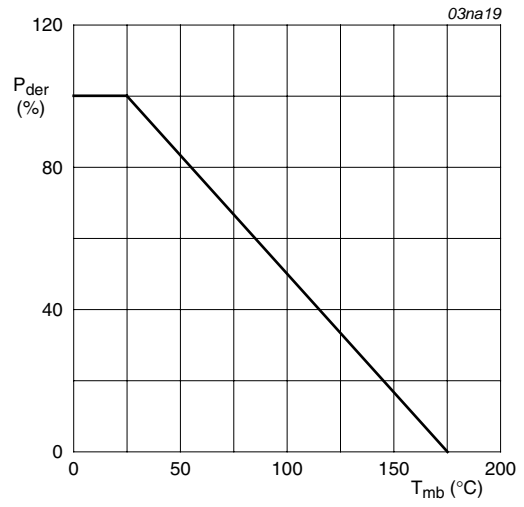
[1] Current is limited by power dissipation chip rating.

[2] Continuous current is limited by package.



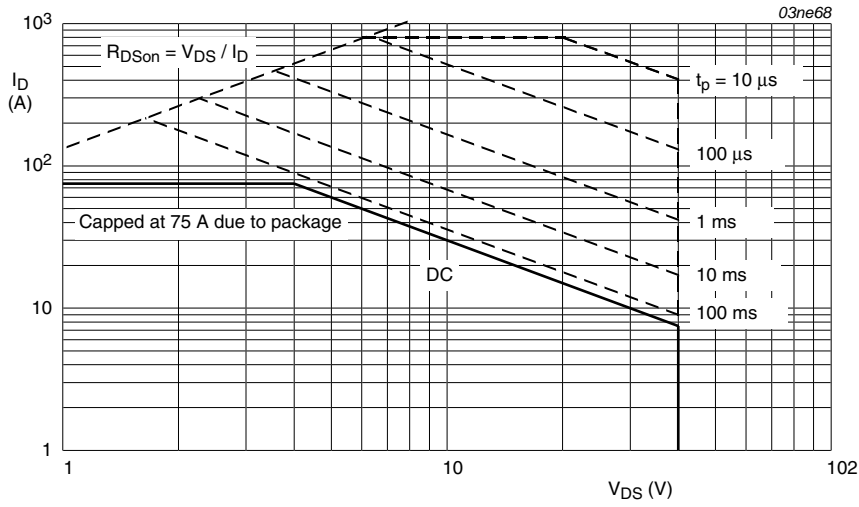
$$V_{GS} \geq 10V$$

**Fig 1. Normalized continuous drain current as a function of mounting base temperature**



$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**Fig 2. Normalized total power dissipation as a function of mounting base temperature**



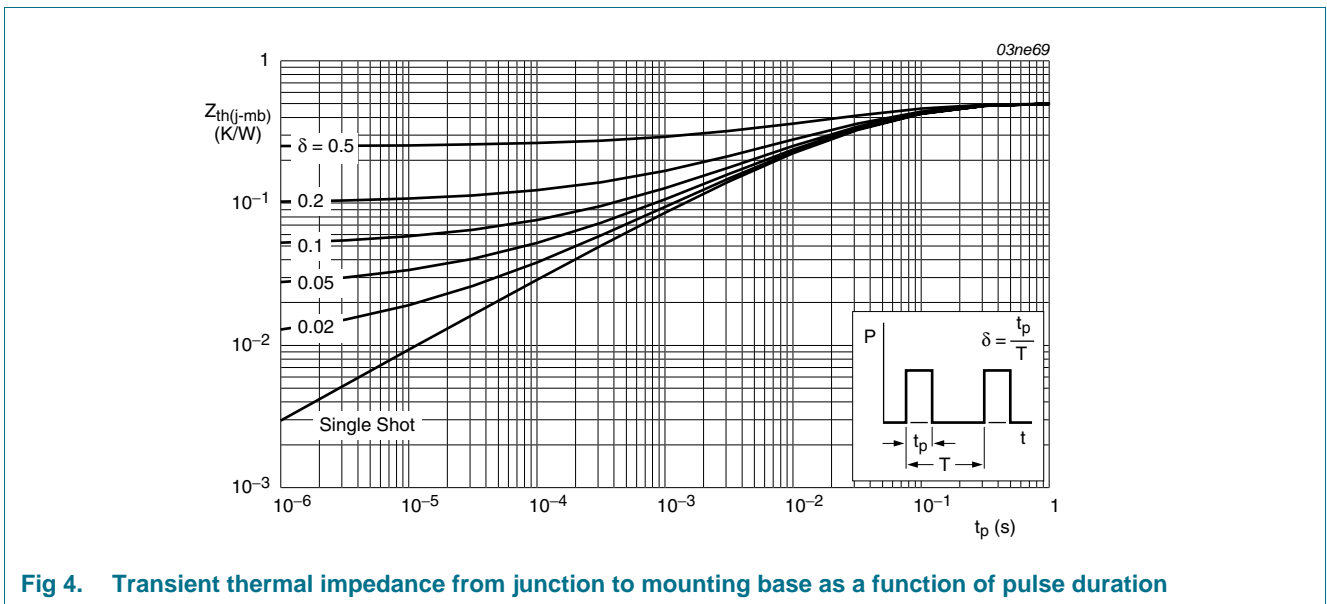
$$T_{mb} = 25^{\circ}C; I_{DM} \text{ is single pulse}$$

**Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage**

**5. Thermal characteristics**

**Table 5. Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	see <a href="#">Figure 4</a>	-	-	0.5	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air	-	60	-	K/W

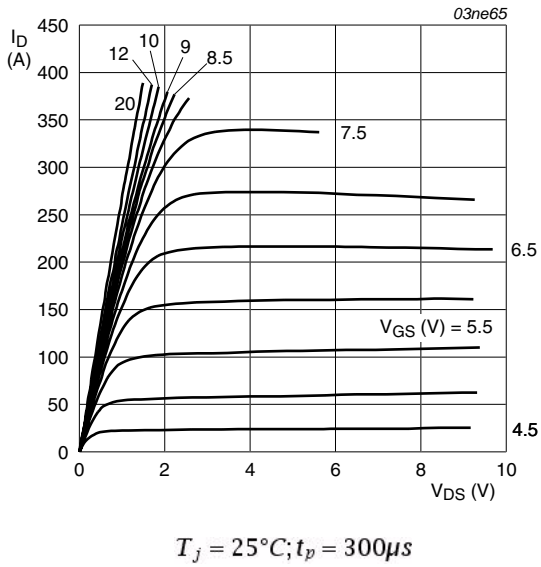


**Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration**

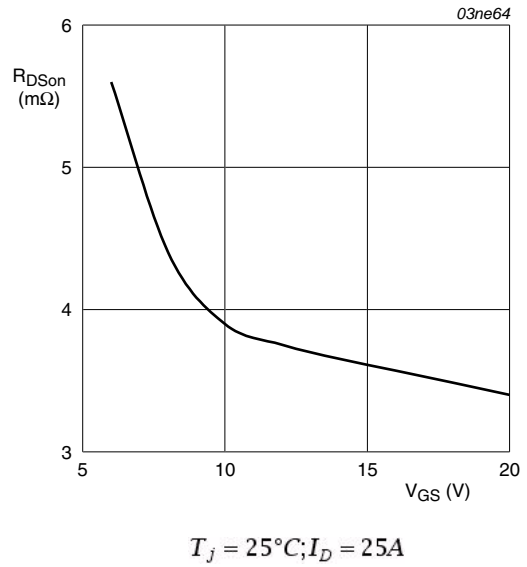
## 6. Characteristics

Table 6. Characteristics

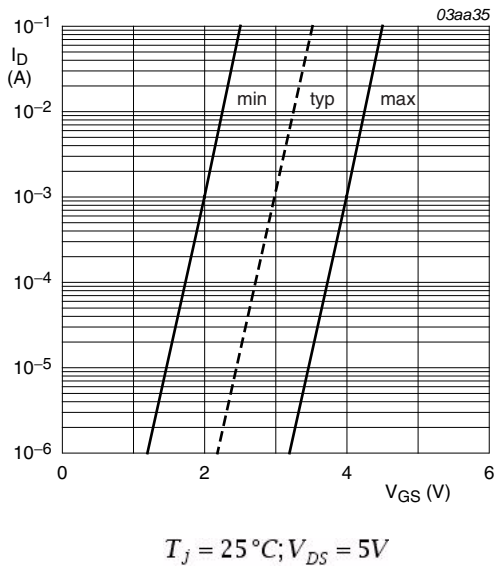
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	36	-	-	V
		$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	40	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a>	2	3	4	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a>	1	-	-	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a>	-	-	4.4	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	-	500	$\mu\text{A}$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.05	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{DS} = 0 \text{ V}; V_{GS} = 20 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
		$V_{DS} = 0 \text{ V}; V_{GS} = -20 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	-	8.5	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	3.9	4.5	m $\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V};$ $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 13</a>	-	117	-	nC
$Q_{GS}$	gate-source charge		-	19	-	nC
$Q_{GD}$	gate-drain charge		-	50	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0 \text{ V}; V_{DS} = 25 \text{ V}; f = 1 \text{ MHz};$ $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 14</a>	-	4300	5730	pF
$C_{oss}$	output capacitance		-	1400	1680	pF
$C_{rss}$	reverse transfer capacitance		-	800	1100	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ }^\circ\Omega; V_{GS} = 10 \text{ V};$ $R_{G(ext)} = 10 \text{ }^\circ\Omega; T_j = 25 \text{ }^\circ\text{C}$	-	33	-	ns
$t_r$	rise time		-	110	-	ns
$t_{d(off)}$	turn-off delay time		-	151	-	ns
$t_f$	fall time		-	76	-	ns
$L_D$	internal drain inductance	from contact screw on mounting base to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$	-	3.5	-	nH
		from drain lead 6 mm from package to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$	-	4.5	-	nH
$L_S$	internal source inductance	from source lead to source bond pad ; $T_j = 25 \text{ }^\circ\text{C}$	-	7.5	-	nH
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 40 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 15</a>	-	0.85	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20 \text{ A}; dI_S/dt = -100 \text{ A}/\mu\text{s};$ $V_{GS} = -10 \text{ V}; V_{DS} = 30 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	96	-	ns
$Q_r$	recovered charge		-	224	-	nC



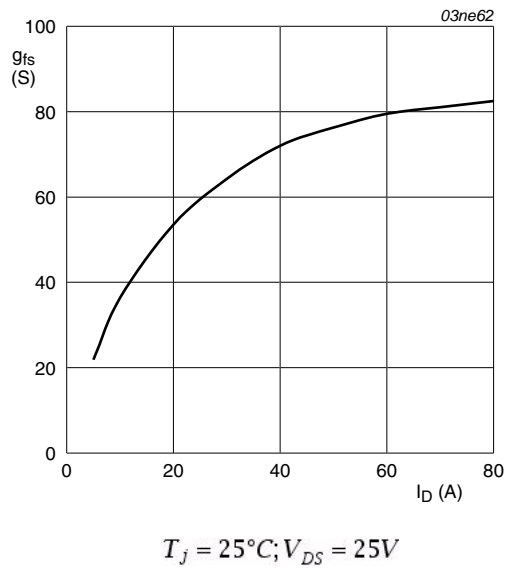
**Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values**



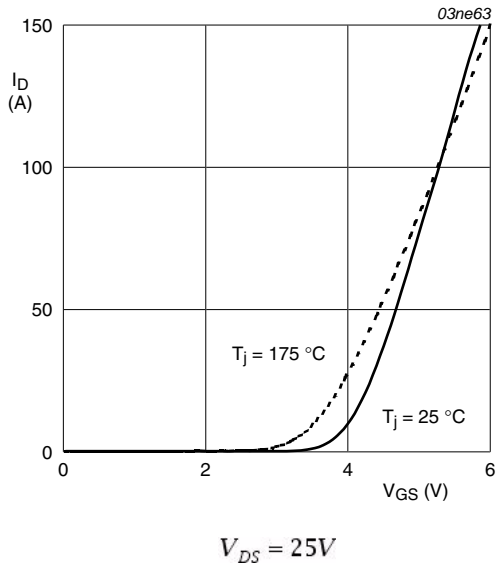
**Fig 6. Drain-source on-state resistance as a function of gate-source voltage; typical values**



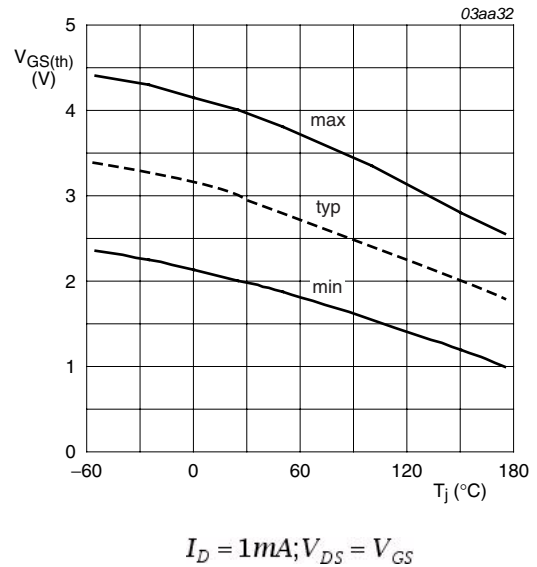
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



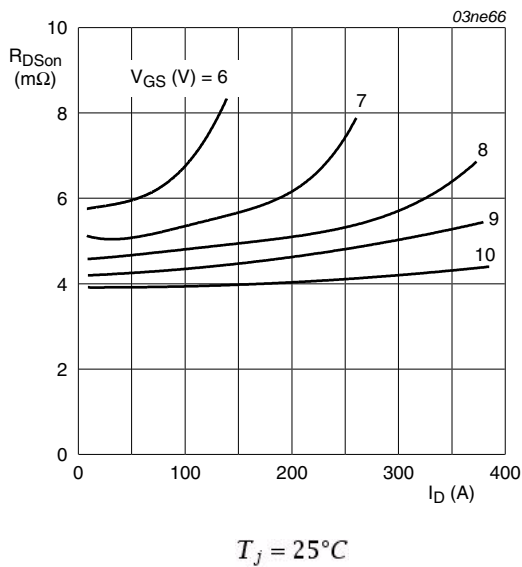
**Fig 8. Forward transconductance as a function of drain current; typical values**



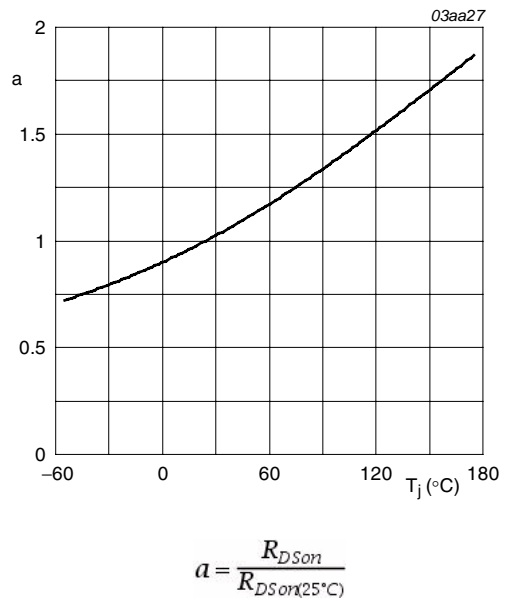
**Fig 9. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



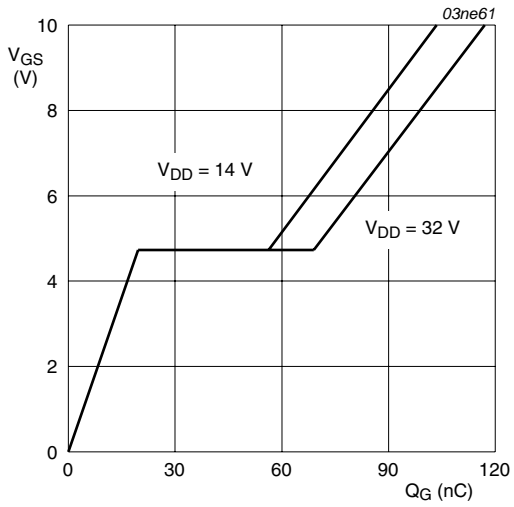
**Fig 10. Gate-source threshold voltage as a function of junction temperature**



**Fig 11. Drain-source on-state resistance as a function of drain current; typical values**

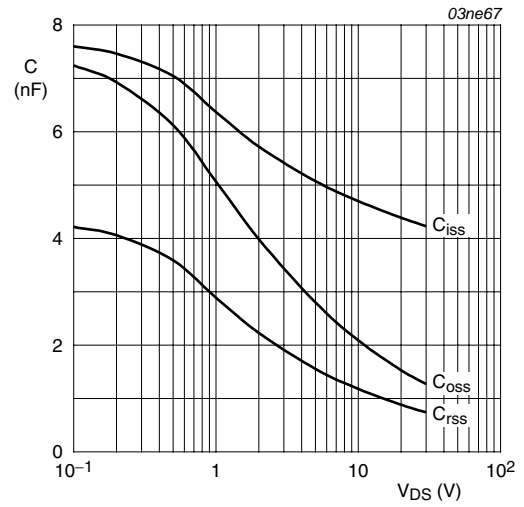


**Fig 12. Normalized drain-source on-state resistance factor as a function of junction temperature**



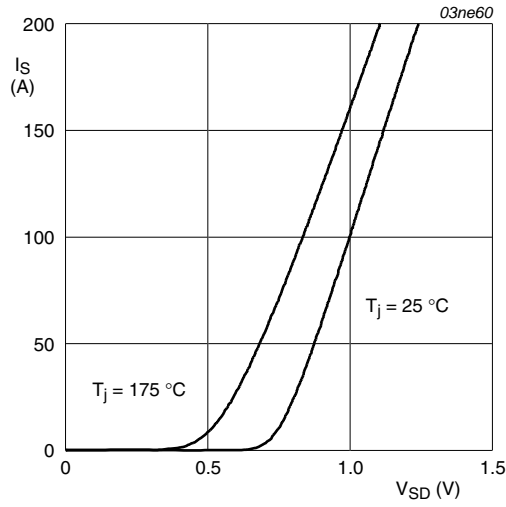
$T_j = 25^\circ\text{C}; I_D = 25\text{A}$

**Fig 13. Gate-source voltage as a function of turn-on gate charge; typical values**



$V_{GS} = 0\text{V}; f = 1\text{MHz}$

**Fig 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



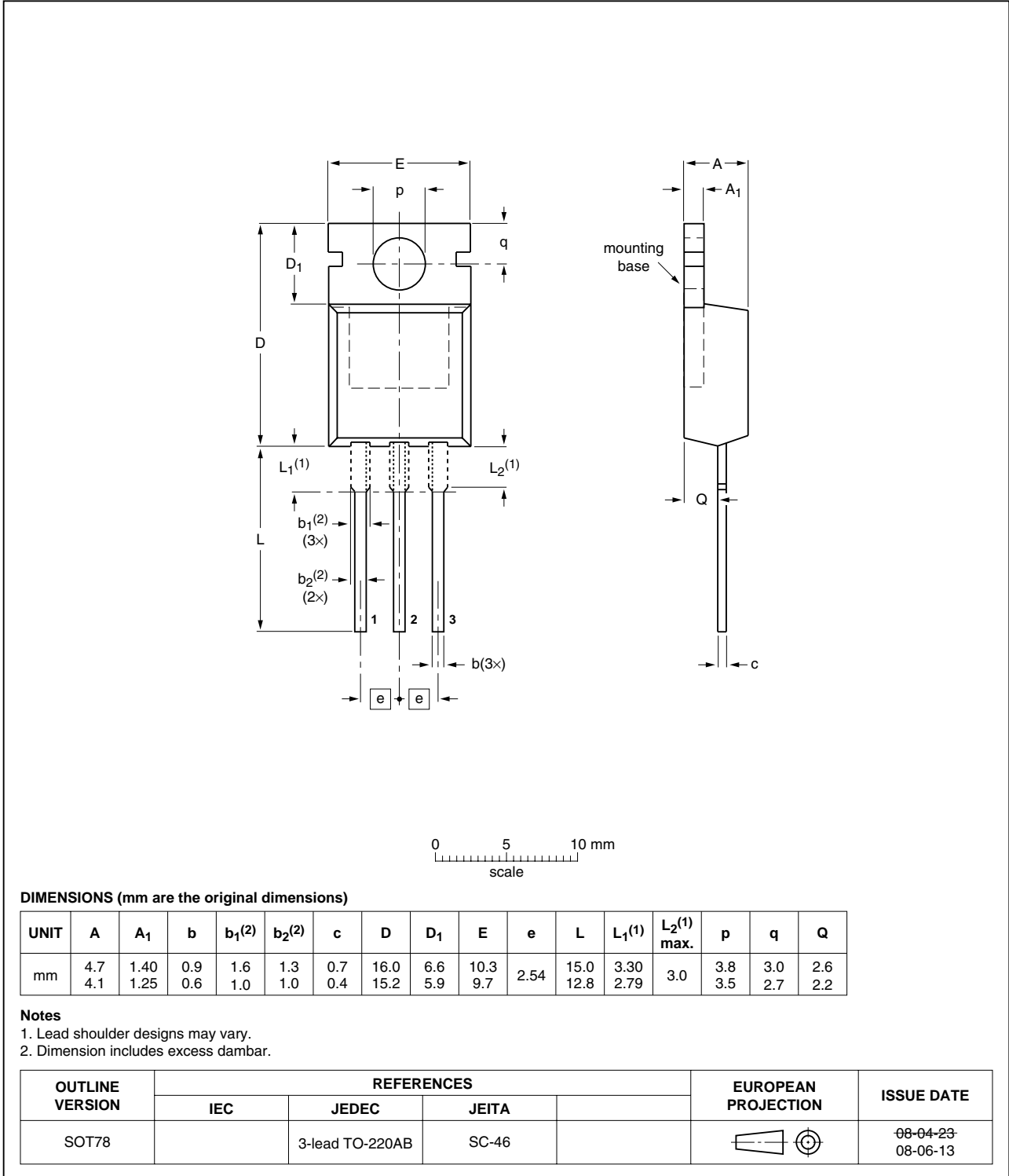
$V_{GS} = 0\text{V}$

**Fig 15. Reverse diode current as a function of reverse diode voltage; typical values**

**7. Package outline**

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78



**Fig 16. Package outline SOT78 (TO-220AB)**

## 8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK7504-40A v.3	20100615	Product data sheet	-	BUK7504_7604_7E04_40A v.2
Modifications:				
				<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• Type number BUK7504-40A separated from data sheet BUK7504_7604_7E04_40A v.2.</li></ul>
BUK7504_7604_7E04_40A v.2	20011107	Product data	-	-

## 9. Legal information

### 9.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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## 11. Contents

<b>1</b>	<b>Product profile</b> . . . . .	<b>1</b>
1.1	General description . . . . .	1
1.2	Features and benefits . . . . .	1
1.3	Applications . . . . .	1
1.4	Quick reference data . . . . .	1
<b>2</b>	<b>Pinning information</b> . . . . .	<b>2</b>
<b>3</b>	<b>Ordering information</b> . . . . .	<b>2</b>
<b>4</b>	<b>Limiting values</b> . . . . .	<b>3</b>
<b>5</b>	<b>Thermal characteristics</b> . . . . .	<b>5</b>
<b>6</b>	<b>Characteristics</b> . . . . .	<b>6</b>
<b>7</b>	<b>Package outline</b> . . . . .	<b>10</b>
<b>8</b>	<b>Revision history</b> . . . . .	<b>11</b>
<b>9</b>	<b>Legal information</b> . . . . .	<b>12</b>
9.1	Data sheet status . . . . .	12
9.2	Definitions . . . . .	12
9.3	Disclaimers . . . . .	12
9.4	Trademarks . . . . .	13
<b>10</b>	<b>Contact information</b> . . . . .	<b>13</b>

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